GENERAL MAINTENANCE

INTRODUCTION

In General Maintenance we will discuss general Monitor service procedures, including alarm code interpretation, service mode operation, and periodic maintenance and battery care. Use the following links for disassembly and reassembly procedures and related component service information.

FUSE REPLACEMENT

There are no user replaceable fuses in the Monitor.

PERIODIC MAINTENANCE

As Required

Perform the following maintenance procedures whenever required.

Integrity of Hoses and Cuffs

When there is doubt about the pneumatic integrity of any NIBP cuff and hose, replace the cuff and hose.

Cleaning of Monitor

CAUTION

Do not clean Monitor with isopropyl alcohol or other solvents.

Wipe the exterior of the Monitor with a cloth slightly dampened with mild detergent or normal hospital bacteriocides. Use dishwashing detergents such as IVORY and JOY (registered trademarks of Procter & Gamble Corp.), or PALMOLIVE (registered trademark of Colgate-Palmolive Corp.)

Keep cooling fan passages clear by cleaning exhaust opening at rear of unit using a soft brush.

Do not immerse unit.

Cleaning of Accessories

Clean the adult cuffs supplied for use with the monitor by hand washing in warm, soapy water. However, take care to avoid entry of water into the cuff and hoses at any time. If water enters the cuff, dry the cuff by passing air through it.

The neonatal cuffs are for single patient use - discard if they become soiled.

Clean cuffs and hoses with a cloth slightly dampened with mild detergent.

Do not immerse hoses.

Do not immerse cuffs without prior application of cuff hose caps.

Clean SpO2 sensor surface before and after each patient use. Clean SpO2 sensor with a cloth slightly dampened with a mild detergent. Wipe SpO2 sensor to ensure all detergent residue has been removed.

Follow manufacturer's instructions for cleaning ECG lead wires and cable.

Compatible cleaning and disinfecting solutions are:

Dishwashing detergents such as IVORY and JOY (registered trademarks of Procter & Gamble Corp.), or PALMOLIVE (registered trademark of Colgate-Palmolive Corp.)

Chlorine bleach disinfectant, 5.25%, various brands, 0.75 cup per gallon of water

CAUTION

Do not apply isopropyl alcohol to the Monitor - some parts can become marred and cracked.

Isopropyl alcohol (for accessories only)

Cidex Formula 7 (registered trademark of Johnson & Johnson Medical, Inc.) or pHisoHex (registered trademark of Winthrop-Breon Laboratories)

Quatenary-based germicidal detergents like VESTAL INSURANCE (registered trademark of the Vestal Corp.), HI-TOR PLUS (registered trademark of the Huntington Corp.), or VIREX (registered trademark of S.C. Johnson & Son Corp.)

For the above, follow manufacturers' recommendations for dilution rate and use. These recommendations are not an endorsement of the manufacturers or of the effectiveness of these materials for cleaning or disinfecting.

Cleaning of CO2 Module

When required, perform sampling system cleaning procedure.

Long-Term Storage

If it becomes necessary to store the Monitor for an extended period of time, remove the modules and batteries. Attach the original packing inserts, and place units into original shipping cartons.

Generally, long-term storage of a nickel-metal hydride battery in either a charged or discharged condition has no permanent effect on capacity. Capacity loss due to self-discharge is reversible, and nickel-metal hydride batteries can recover to full capacity by proper recharging. For example, full capacity of a nickel-metal hydride battery that was stored at room temperature for up to one year can be restored by cycling through repeated charge/discharge cycles.

Long-term storage at high temperatures can lead to deterioration of seals and separators and should be avoided.

Annual Procedures

Perform the test procedures described in Service Mode Operation every twelve months, or whenever the accuracy of any reading is in doubt.

Biennial Procedures

An internal, 9V, non-rechargeable alkaline battery acts as an alarm backup and helps preserve memory when the Monitor is off. The backup battery is normally not used, but should be replaced every two (2) years. A system alarm message will be generated if backup battery replacement is required.

CARE OF STORAGE BATTERIES

The Monitor uses from one to three "smart" nickel-metal-hydride (NiMH) storage batteries—two of which are user-replaceable. The batteries can be charged at any time without reducing the charging capacity.

The NiMH battery has an external power indicator on the front of the battery. This indicator displays the amount of power remaining in the battery. To use the indicator, press the button. One to four lighted status bars indicate the amount of power (in percentages) remaining, as follows:

Status Bar	% Capacity
100	76-100
75	51-75
50	26-50
25	11-25
Flashing 25	10 or less

The batteries provide data that allows the Monitor to determine battery presence, battery use, state of charge, and remaining life left. This information (Table 3-1) is displayed on the Monitor screen. Refer to Table 3-2 for information about battery-related alarms. Refer to Table 3-3 for remedies for common battery problems.

Although all DINAMAP batteries are identical internally, they are marked with different part numbers for various countries, as follows:

Part Number	Country
633153	USA
300954	Germany
300955	UK, Australia
300956	France
300957	Spain, Hispanic Countries

A 4-digit lot number is imprinted on the top of each battery. This can be used as a reference number if the battery is unable to report serial number and date of manufacture.

Procedures For First Use

Follow these procedures to condition a new NiMH battery and optimize its performance:

- The internal battery and any installed user-replaceable batteries will automatically charge when the AC power supply is in use. When the battery is charged for the first time, the charger may indicate prematurely that charging is complete. This is normal and can happen with all rechargeable batteries when first charged.
- Calibrate the battery as described in Battery Tests.
- Fully charge the battery after calibration.

Although new batteries can be used immediately upon being calibrated, they should be charged and then discharged three times to ensure optimum performance.

Table 3-1. Displayed Battery Data

Item	Description
Voltage	Actual battery voltage, in millivolts. Battery will not be used if voltage drops below 10.3 volts
Current	Actual current flow, in milliamps. A plus sign indicates a charging current; a negative sign indicates the battery being discharged
Temperature	Internal battery temperature, in °C
Design capacity	Maximum design capacity, in milliamp hours
Full charge capacity	Actual capacity of battery, in milliamp hours, based on the discharge load during calibration. This number is typically about 90-95% of design capacity when new, decreasing to 75-85% after 300-400 cycles. Normal replacement of the battery should be based on this value, and the amount of usable time offered as this value decreases
Rel state of charge	Relative state of charge of battery; as a % of full charge capacity
Charge requested	Charging current, in milliamps, that the battery is requesting
Max error	Amount of error in fuel gauge. If this is greater than or equal to 10%, calibration is necessary, and the battery calibration status changes to "Cal required"
Calibration status	"Calibrated," "Cal required," or "In progress"
Manufacturer name	At the time of publication, only Energizer batteries built specifically for the Monitor are accepted by system software
Device name	633153n, where n is the revision
Serial number	Four-digit number used in alarm history postings for battery calibration messages and errors. This number, when combined with manufacture date, gives a unique identifier for each battery. Use both numbers when referring to a battery for servicing. If a battery is dead and cannot be charged, refer to the lot number stamped at the top
Manufacture date	Month/day/year of manufacture
Cycle count	Number of battery charge/discharge cycles

Table 3-2. Battery Alarms

Alarm Type	Indication	Probable Cause
BATT N - WRONG TYPE - REMOVE or INTERNAL BATT - WRONG TYPE -REMOVE	Message appears in alarm message field	Unapproved battery engaged
BATT N - CHECKING or INTERNAL BATT - CHECKING	Message appears in alarm message field	Noncommunicating battery engaged
BATT N FAIL - REMOVE	Message appears in alarm message field	Noncommunicating battery #1 or #2 has been charged and still does not respond or battery #1 or #2 loses voltage or communication or BATT N is not accepting proper charge
INTERNAL BATT FAIL - REPLACE NOW	Message appears in alarm message field	Internal battery loses voltage or communication or is not accepting proper charge
< 00:30 BATTERY	Message appears in alarm message field and in SelectBox	30 minutes remaining in battery life
< 00:10 BATTERY	Message appears in alarm message field	10 minutes remaining in battery life
SHUTTING DOWN	Message appears in alarm message field	< 1 minute remaining in battery life. Monitor may shut down anytime after 45-60 seconds
AC FAIL - < 00:30 BATTERY	Message appears in alarm message field and procedural alarm sounds	Upon loss of AC power, the internal battery is engaged with less than 30 minutes of life (but more than 10 minutes) remaining
AC FAIL - < 00:10 BATTERY	Message appears in alarm message field and crisis alarm sounds	Upon loss of AC power, the internal battery is engaged with less than 10 minutes of life remaining
BATT N FROZEN or INTERNAL BATTERY FROZEN	Message appears in the alarm message field	Battery is too cold to charge

Table 3-2. Battery Alarms (Continued)

Alarm Type	Indication	Probable Cause
CHECK COOLING FAN	Message appears in the alarm message field	Monitor's internal temperature is too high. Cooling fan may be blocked or inoperative
BATT N CAL FAIL or INTERNAL BATT CAL FAIL	Message appears in alarm history field and in the SelectBox	Battery calibration failed due to high ambient temperature
BATT N CAL STOP or INTERNAL BATT CAL STOP	Message appears in alarm history field and in SelectBox	Battery calibration stopped by user (removal of battery or AC power disconnected)
9V BATTERY LOW - REPLACE NOW	Message appears in alarm message field and procedural alarm sounds	Internal 9V battery requires replacement

Table 3-3. Battery Troubleshooting

Trouble	Probable Cause	Remedy
Battery inoperative or does not last very long.	Battery not fully charged.	Calibrate and charge new batteries before use. Refer to Procedures For First Use.
	Battery in long-term storage or nonuse.	Charge and discharge battery up to three times for optimum performance.
	Battery installed improperly.	Remove and reinstall battery so connector is properly seated.
		Perform battery test procedure.
Battery charged for only a short period of time before indicating full charge.	Improper procedure for charging batter for first time use.	When charging battery for first time, charger may indicate prematurely that charging is completed. Discharge battery and repeat charging procedure.
Battery will not charge.	Charging battery in unusually cold or hot temperatures.	Charge at basic room temperature of 59° F (16° C) to 86° F (30° C). Slowly bring battery to basic room temperature before recharging. Batteries cannot be fully charged unless internal temperatures between 57° F (15° C) and 109° F (40° C).
	Charger not type recommended by Johnson & Johnson Medical, Inc.	Use Monitor itself, or a Johnson & Johnson Medical, Inc. recommended battery charger.

Battery Charging

The Monitor charges the NiMH batteries whenever the AC power supply is in use. The Monitor reads battery status communicated by the smart batteries, and delivers to each battery the charge current requested, up to a maximum of 2400mA (less at times of peak monitor activity). Battery charging continues as long as the Monitor is connected to the AC power supply, even when the Monitor is turned off.

- Batteries should be charged (and calibrated, if necessary) before first use or after prolonged periods of storage.
- The battery should be charged before use, because a charged battery loses some charge when left in storage. Charging is done automatically by the Monitor if a battery is inserted and the Monitor is connected to the AC power supply.
- The battery should be charged at room temperature (59° F - 86° F; 16° C - 30° C).
- It is normal for the battery to become warm during charging or after use.
- Batteries can be charged or topped-off at any time. It is not necessary to wait until they are fully discharged.
- If a battery is idle, it should be fully charged and then discharged once a month, or calibrated once a month, to ensure optimum performance.

Batteries have a three step charging protocol, as follows:

1. **Fast charge** - Battery will request 3000 milliamps for an initial charge up to approximately 90%. Monitor will deliver a maximum of 2400 mA, less if monitor is consuming peak power for operation (i.e., NIBP pump and recorder both on).

2. **Top-up charge** - Battery will request 300 milliamps to top-up battery to full (not always 100%).

3. **Trickle charge** - Battery will request 75 milliamps whenever it is full. If only the internal battery is present, the monitor will deliver 75 milliamps full time. If two batteries are present, the monitor will deliver 150 milliamps to each battery for half of the time, alternating between the two batteries. If all three batteries are present, the monitor will deliver 225 milliamps for one-third of the time, cycling across all three batteries.

Batteries are fast charged in the following order.

- The internal battery is always fast charged first.
- The optional user-replaceable battery #1 or #2, whichever has the higher initial voltage, is fast charged next.
- The other optional user-replaceable battery is then fast charged.
- All batteries present are then topped up one at a time to full.
- To keep maximum charge, batteries are continuously trickle-charged on a rotating basis anytime they are fully charged and installed in the Monitor.

- The battery's internal temperature is monitored and will be charged at a reduced rate if the temperature reaches 57° F (15° C) or colder.
- The battery will continue to be charged at a reduced rate until its internal temperature rises above 57° F (15° C), after which fast charging will resume.
- If a battery is 32° F (0° C) or colder, it will not charge.
- If the battery temperature is 118° F (48° C) or greater, it will not charge until its internal temperature cools down to 109° F (40° C).

Deep Battery Discharging

If a Monitor is allowed to fully run down its internal battery, the 9V battery has to be replaced. In addition, the internal battery may be so discharged that it can no longer report its status to the system. If this occurs, the battery can be recharged using an external charger, or by the Monitor using the following method:

1. The Monitor will continuously display the message INTERNAL BATT - CHECKING while attempting to recharge the battery enough to restore its status reporting.
2. Once the battery can report its status, the internal battery can be recharged in the normal manner.

GROUND RESISTANCE TEST

Using a safety analyzer (Dynatech Nevada model 432HD or equivalent), proceed as follows to check the ground resistance of the Monitor:

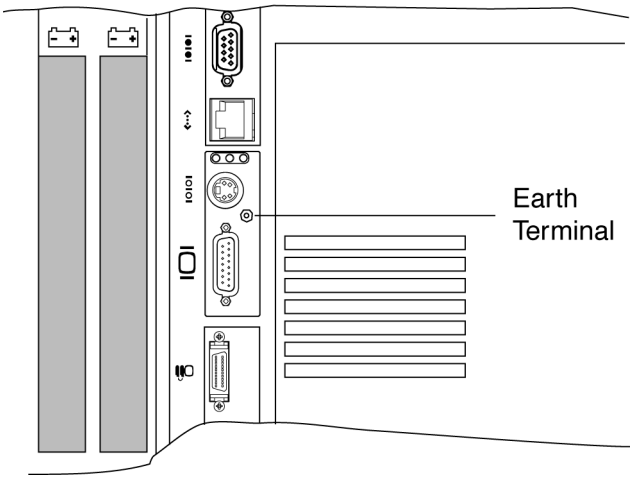
1. On the safety analyzer, set the MODE switch to Power Cord Resistance.

2. Turn off the safety analyzer test receptacle.

3. Connect Monitor under test external AC power supply to safety analyzer.

4. Connect safety analyzer Kelvin cable between the red Current Meter jack and the earth terminal (indicated in figure below) at the rear of the Monitor under test.

5. Turn on the safety analyzer, and note that the indicated resistance is less than 0.2 ohm.



ERROR MESSAGES

Refer to Table 3-2 for information about procedural alarms that involve battery operation. If any other alarms appear that are not listed in the paragraphs that follow, record the error message and report the failure to Customer Support. Refer to the Operation Manual for information about patient alarms and general procedural alarms.

System Failures

When a system failure is encountered, the error code is displayed on the screen for five seconds and the system enters failsafe mode. The error code is logged in the history log.

General system error codes are listed below. If any other **SD**, **SY**, or similar code appears, report it to Customer Support.

Error Code	Description
SD-2	Communications failure or software failure with PIC
SD-6	Speaker test failed
SY-19	Software detected power failure
SY-20	Checksum of code in flash memory is not valid
SY-45	Normal communications not being received regularly (every approx. 5 seconds) from PIC
SY-46	PIC indicates failsafe checking is OFF

Module Failures

These cause disconnection of a module or parameter, and are accompanied by a dialog box that appears at the bottom of the screen.

The message

Module level failure detected.
FAIL CODE: = (x, y)

is a module reported failure, where x = slot number counting from the right of the glove box, and y = 16-bit hexadecimal error code. The error code may be either a system initiated failure or a failure reported by a module. The system initiated error codes are as follows:

Error Code	Description
0x0000	if the module is not communicating at all
0x0001	if the module has been reset and is waiting for the system to reconnect to it

Hardware Errors

These error codes, which are common to all modules, indicate some internal self-check test of the hardware has failed, and service is required.

Error Code	Description
0x2001	HW, Time base failure
0x200A	HW, Power supply, System
0x2014	HW, ModuleString checksum failure
0x201E	HW, RAM test failure
0x2028	HW, ROM checksum failure
0x2032	HW, Isolation interface comm failure

ECG/RESP/TEMP Module Errors

Error Code	Description
0x3465	HW, Isolated interface front-end scan error

Parameter Failures

These cause disconnection of a module or parameter, and are accompanied by a dialog box that appears at the bottom of the screen.

The message

Parameter has been disconnected due to a module error.
FAIL CODE: = (x)

is a parameter initiated failure, where x = module failure code, a decimal number.

NIBP Messages

Fail Code	Description
110	Overpressure circuit failure
111	Overpressure jumper installed
120	FPT test failure
130	EEProm read failure
131	EEProm write failure
140	Transducer initialization failure
141	Calibration of a transducer channel's zero failed
142	Calibration of a transducer channel's span failed
150	Auto zero failure
160	PT1 reference failure
161	PT2 reference failure
162	OVC reference failure
170	Pump current failure
171	Pump current value out of range
180	Excessive leakage
181	Tank pumpup error
182	Tank pressure settling time out
183	Too many retries to calibrate pump current for tank
184	Tank volume too small
190	Commands out of sequence
200	OVP setpoint not found
210	Pump stuck on during idle
220	Valve in illegal state

Temperature Messages

Fail Code	Description
103	Excitation out of range
104	Offset out of range
105	Test resistor out of range
106	Test relay malfunction

IP Messages

In operate mode, the Fail Code is reported as described in Parameter Failures. In service mode, the Service Mode Code (hex) is displayed on the screen as a Parameter Fatal Error (hex).

Operation Mode Fail Code	Service Mode Code (hex)	Description
101	0x4065	Offset calculation failed while being done in service mode
102	0x4066	Gain calculation failed while being done in service mode
104	0x4068	Error on retrieving gain and offset from EEPROM
105	0x4069	Plus 9 supply failed
106	0x406A	Minus 9 supply failed
107	0x406B	Minus 5 supply failed
108	0x406C	ISO interface error
110	0x406E	Offset and gain done at powerup failed to meet test specs
111	0x406F	Step test failed (service mode only)

SpO2 Messages

In operate mode, the Fail Code is reported as described in Parameter Failures. In service mode, the Service Mode Code (hex) is be displayed on the screen as a Parameter Fatal Error (hex).

Operation Mode Fail Code	Service Mode Code (hex)	Description
103	0x4067	OEM communication stopped

CO2 Messages

In operate mode, the Fail Code is reported as described in Parameter Failures. In service mode, the Service Mode Code (hex) is displayed on the screen as a Parameter Fatal Error (hex).

Operation Mode Fail Code	Service Mode Code (hex)	Description
105	0x4069	OEM power supply failed
106	0x406A	OEM indicates barometric pressure failure
107	0x406B	OEM indicates its own self test failed on power-up

Parameter Disconnected Failure

The message

Parameter has been disconnected due to module error.
FAIL CODE: = (x)

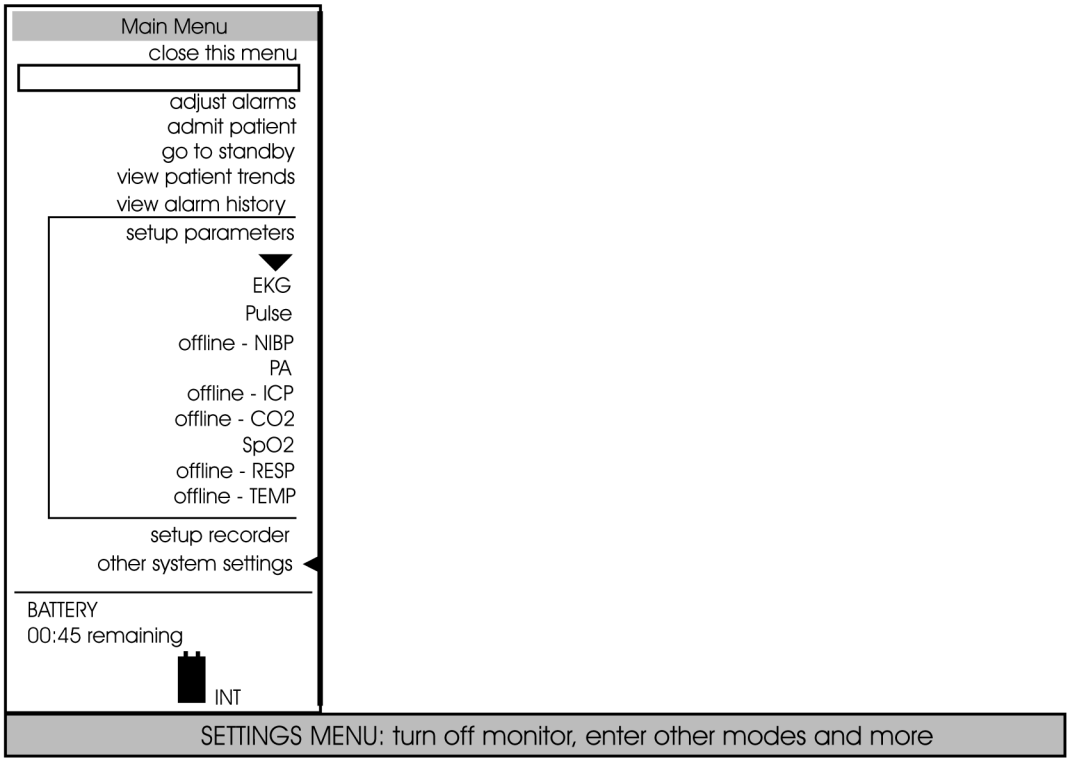
is a parameter failure initiated by the system. The failure indicates a communications failure with the parameter or a non-compatible parameter (older or newer communications protocol).

SERVICE MODE OPERATION

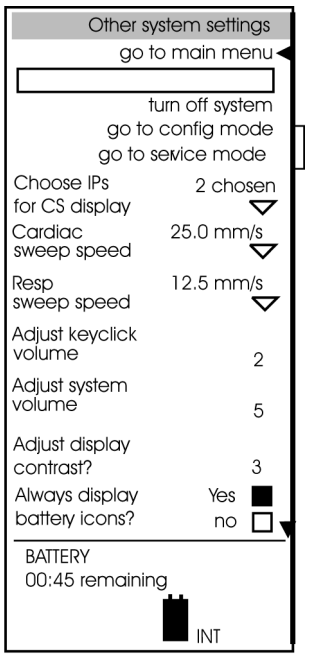
The Monitor service mode exercises the built-in diagnostic features of the Monitor and interchangeable modules. Access the service mode from a cold start by proceeding as follows:

1. Momentarily press the on/off button at the rear of the Monitor. Observe that a beep sounds and that the power up screen displays.

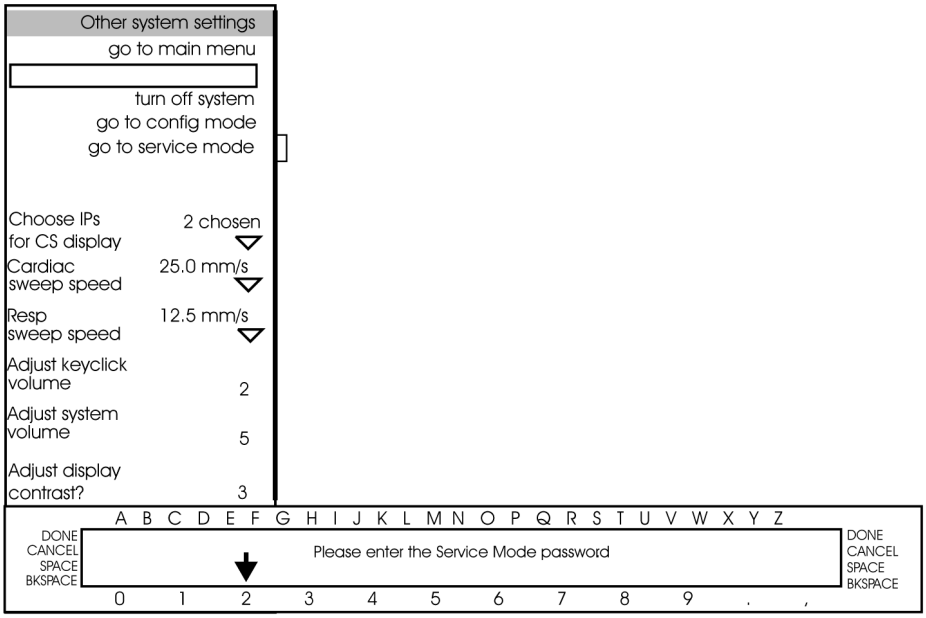
2. Press the Select Knob to answer **no** to the **admit patient** prompt, rotate the knob, and observe that a main menu with a left side somewhat similar to that shown below is displayed.



3. Rotate the Select Knob to select **other system settings**, and press the knob. Observe that the menu left side is similar to that shown below.

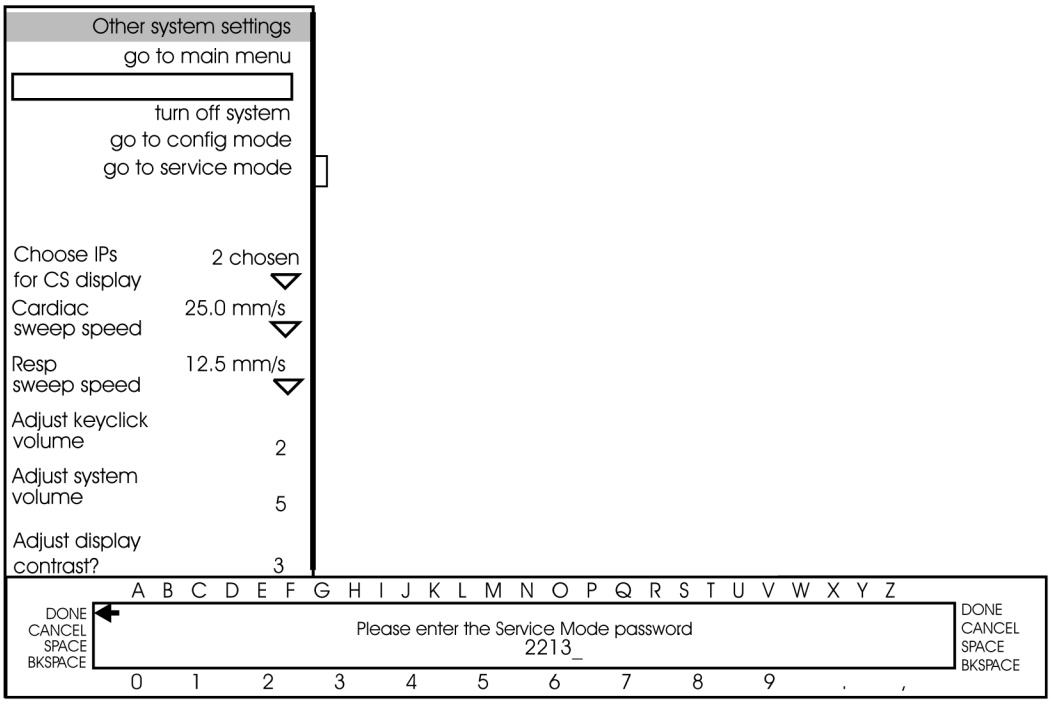


4. Select **go to service mode**. Rotate the knob to the right, and press the knob again to answer **yes** to the prompt. Note that the menu changes as shown below.



Hint: press and turn SelectKnob to enter data / choose DONE

5. Observe that a row of numbers is displayed at the bottom of the screen. Key in the access code **2213** by using the Select Knob to input each numeral in sequence, as shown below.



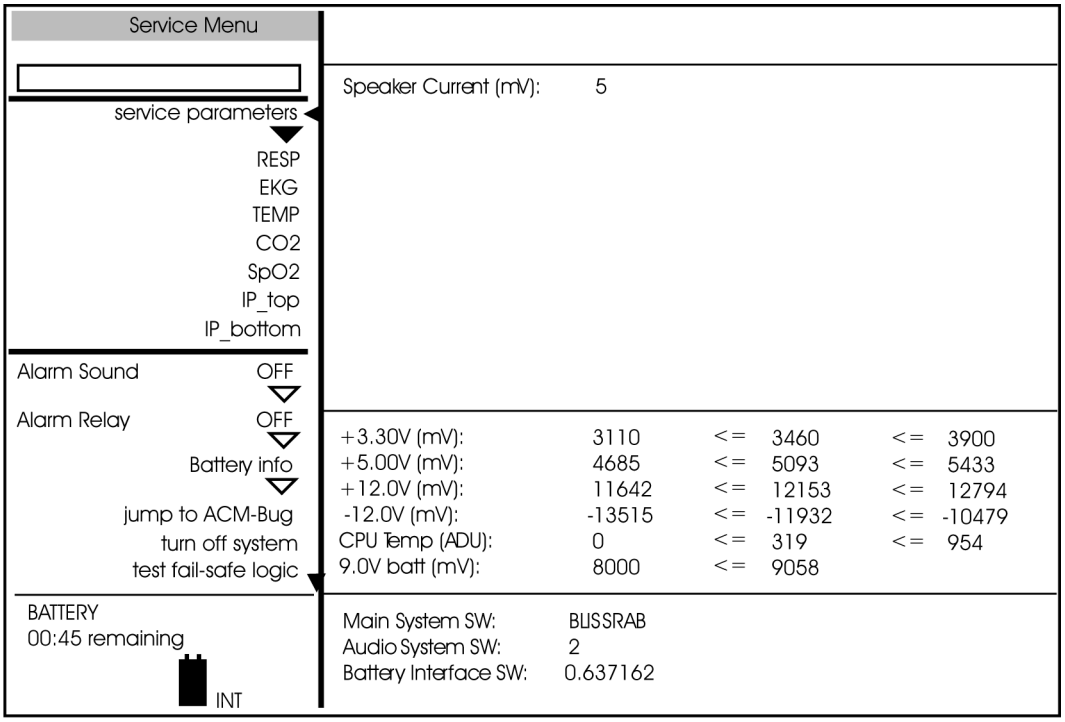
Hint: press and turn SelectKnob to enter data / choose DONE

6. When the screen displays **2213**, use the knob to select **DONE**. Observe that the power up screen again displays.

NOTE

The service mode can also be entered directly from a cold start by pressing and holding the on/off button at the rear of the unit, then pressing the Select Knob before releasing the on/off button.

7. Rotate the knob and observe that the **Service Menu** then displays. As shown below, the service menu **service parameters** area displays a list that corresponds to the number and type of interchangeable modules that have been installed and detected by the Monitor. If the service mode was entered directly (as described in the NOTE above), **enter service password** appears above the service parameters on the service menu. If recalibration of any component is required, the password MUST be entered (as described in steps 5. and 6.) before any changes to calibration can be made.

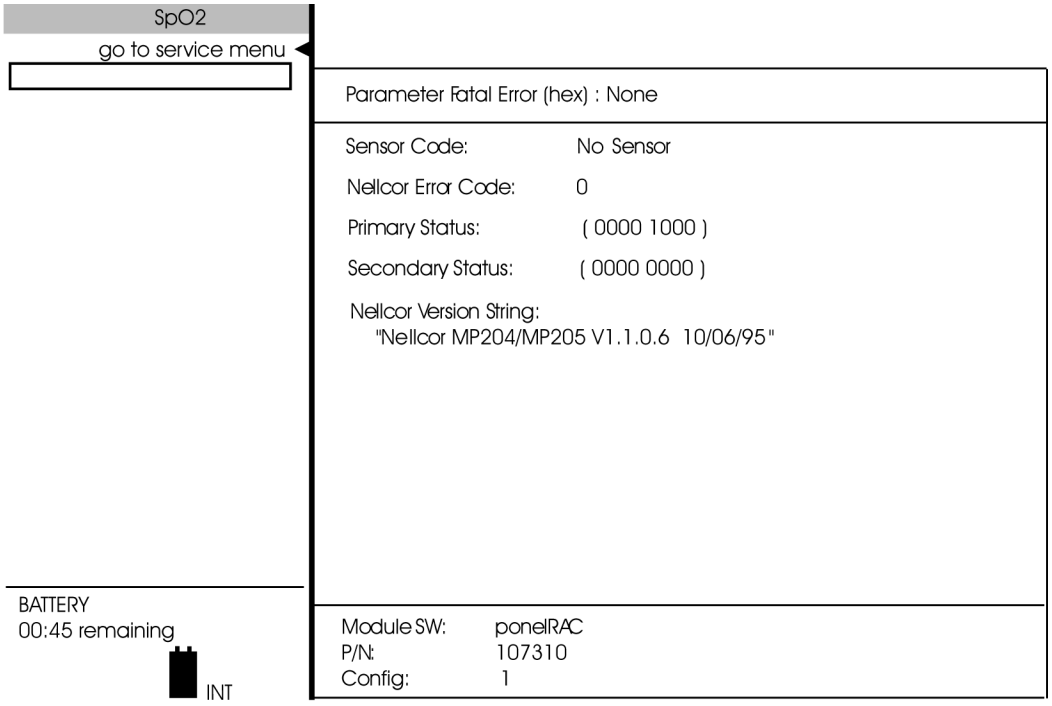


8. For each parameter, there are one or more service screens that display operating values and tests that are applicable to the parameter type. Refer to the following paragraphs for information about each parameter. At the conclusion of the tests, select **go to service menu** at the top of the screen to return to the Service Menu main screen.

SpO2 Tests

1. Disconnect all sensor cables from the SpO2 Module, and ensure that the SpO2 Module is installed.

2. From the Service Menu, use the Select Knob to select the SpO2 service parameter, and press the knob. The SpO2 service menu should appear, with the **Sensor Code** displaying **No Sensor** and the **Primary Status** and **Secondary Status** codes displayed as shown below.



3. Insert the Nellcor PT-2500 pocket tester into the Module front panel SpO2 sensor socket (use an extension cable if necessary), and press until fully seated in the socket.

4. After a few seconds, the red LED should light on the pocket tester. The SpO2 service menu **Sensor Code** should display **63**. The **Primary Status** code should display **0000 1001**, and the **Secondary Status** code should display **0000 0000**.

5. The sensor code display allows additional testing for correct interpretation of the sensor code specified for each oximetry sensor (codes for most sensors are in the range of 63 to 80).

NIBP Tests

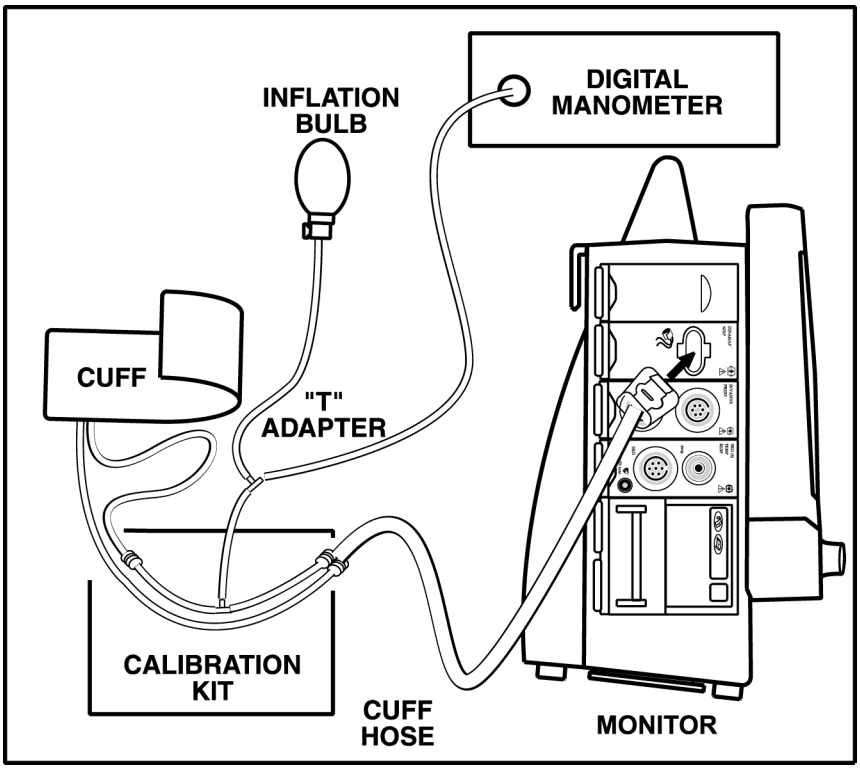
Perform the following tests to determine that the NIBP Module is functioning normally.

Leak Test

CAUTION

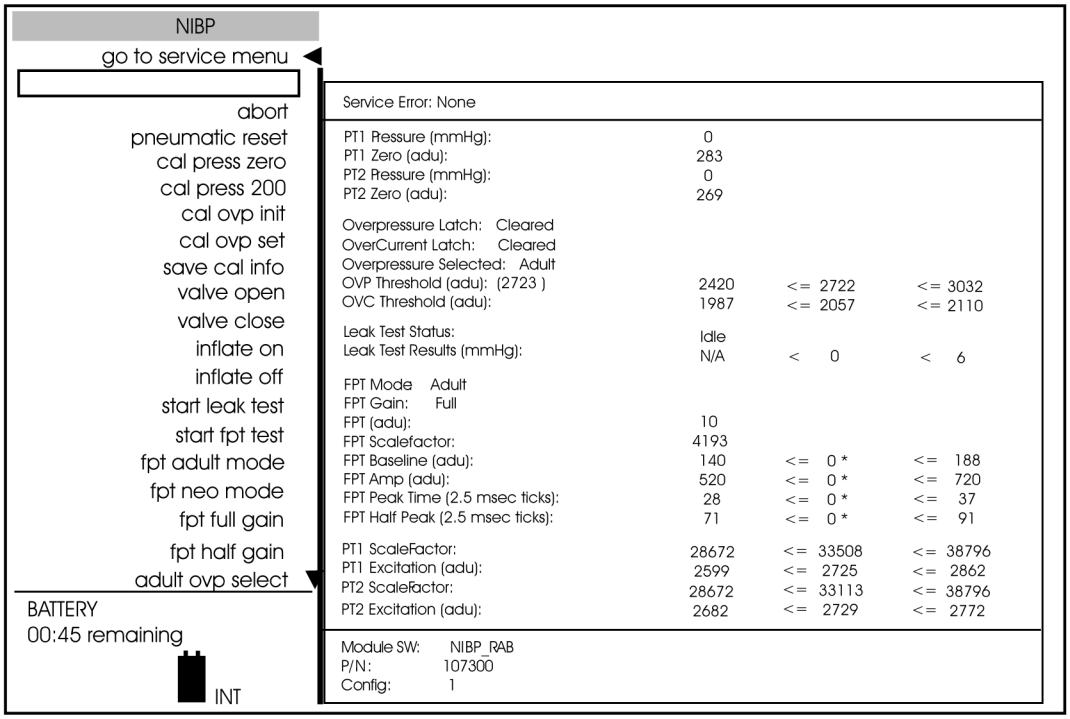
Calibration equipment should always be kept dry and free of particulate matter. Moisture or foreign substances introduced into the pneumatic system can cause damage to the unit.

1. Using the calibration kit (part number 320-246), an adult cuff and air hose, and a manometer, set up the equipment as shown in the NIBP Test Setup diagram (below). Connect the hose to the NIBP Module. Make sure all fittings are tight, and that valve on inflation bulb is closed tightly.



NIBP Test Setup

2. From the Service Menu, use the Select Knob to select the NIBP service parameter, and press the knob. The NIBP service menu should appear as shown in the NIBP Services Menu (below).


NIBP
go to service menu
abort
pneumatic reset
cal press zero
cal press 200
cal ovp init
cal ovp set
save cal info
valve open
valve close
inflate on
inflate off
start leak test
start fpt test
fpt adult mode
fpt neo mode
fpt full gain
fpt half gain
adult ovp select
BATTERY
00:45 remaining
INT
Service Error: None
PT1 Pressure (mmHg): 0
PT1 Zero (adu): 283
PT2 Pressure (mmHg): 0
PT2 Zero (adu): 269
Overpressure Latch: Cleared
OverCurrent Latch: Cleared
Overpressure Selected: Adult
OVP Threshold (adu): (2723) 2420 <= 2722 <= 3032
OVC Threshold (adu): 1987 <= 2057 <= 2110
Leak Test Status: Idle
Leak Test Results (mmHg): N/A < 0 < 6
FPT Mode Adult
FPT Gain: Full
FPT (adu): 10
FPT Scalefactor: 4193
FPT Baseline (adu): 140 <= 0 * <= 188
FPT Amp (adu): 520 <= 0 * <= 720
FPT Peak Time (2.5 msec ticks): 28 <= 0 * <= 37
FPT Half Peak (2.5 msec ticks): 71 <= 0 * <= 91
PT1 ScaleFactor: 28672 <= 33508 <= 38796
PT1 Excitation (adu): 2599 <= 2725 <= 2862
PT2 ScaleFactor: 28672 <= 33113 <= 38796
PT2 Excitation (adu): 2682 <= 2729 <= 2772
Module SW: NIBP_RAB
P/N: 107300
Config: 1

NIBP Service Menu

3. Use the Select Knob to select **pneumatic reset**, and press the knob.

4. Use the Select Knob to select **valve close**, and press the knob.

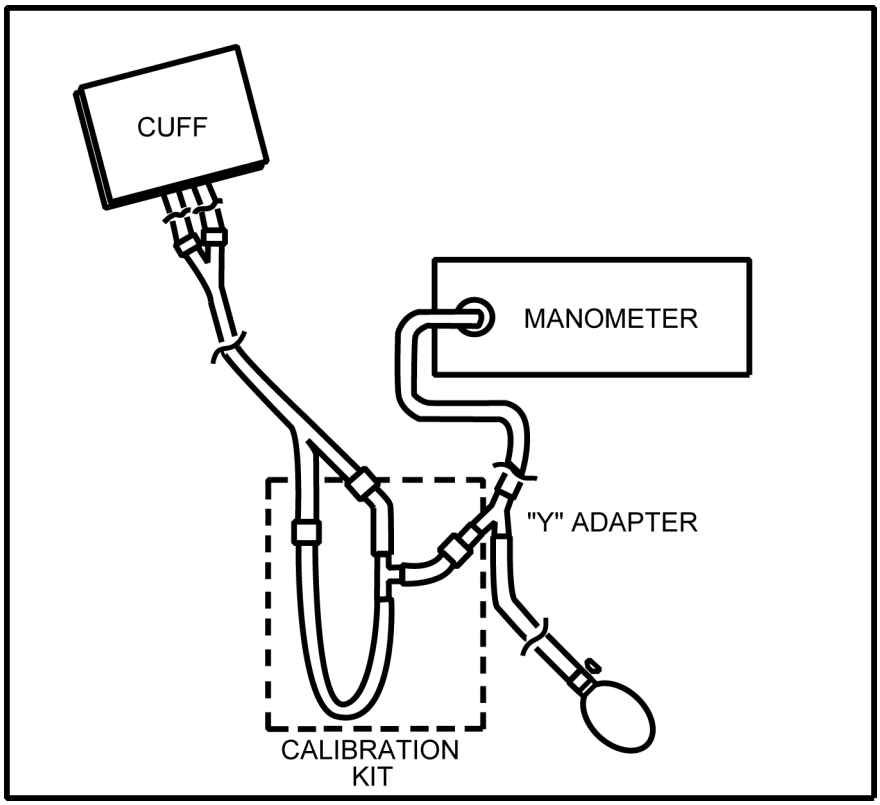
5. Use the Select Knob to select **start leak test**, and press the knob. Observe that the **Leak Test Status** message on the menu indicates **Busy**.

6. Observe that the pump begins inflating the system to about 200 to 210 mmHg, then stops pumping. The Monitor then begins to calculate system pressure loss rate.

7. After about 60 seconds, the pressure is released, and the menu should display **Leak Test Status Passed**, and the **Leak Test Results** indication should be a value less than 6. **Service Error: None** should continue to display.

8. If the menu displays **Leak Test Failed**, go to step 9.

9. Using the calibration kit (part number 320-264), an adult cuff and air hose, and a manometer, set up the equipment as shown in the Leak Test Setup diagram (below).



Leak Test Setup

10. Close the pressure release valve on the manometer inflation bulb and slowly pump up the pressure until the manometer indicates 200 mmHg ±1 mmHg.

11. Verify the pressure indicated on the manometer remains within 5 mmHg of 200 mmHg for 60 seconds. If not, either the cuff or hose or both may be defective. If the cuff and hose pass this test, repeat steps 1. through 7. to try to isolate the leak to the Module. Repeat the leak test for all cuff and hose combinations to be used with the Monitor.

NIBP Calibration Check

CAUTION

Calibration equipment should always be kept dry and free of particulate matter. Moisture or foreign substances introduced into the pneumatic system can cause damage to the unit.

1. Using the calibration kit (part number 320-246), an adult cuff and air hose, and a manometer, set up the equipment as shown in the NIPB Test Setup diagram. Connect the hose to the NIBP Module. Make sure all fittings are tight, and that valve on inflation bulb is closed tightly.

2. From the Service Menu, use the Select Knob to select the NIBP service parameter, and press the knob. The NIBP service menu should appear as shown in the NIBP Service Menu diagram.

3. Use the Select Knob to select **pneumatic reset**, and press the knob.

4. Use the Select Knob to select **valve close**, and press the knob.

5. Observe that both **PT1 Pressure** and **PT2 Pressure** equal initial values of **0**.

6. Connect hose to NIBP Module.

7. Fold the adult cuff so the index line is aligned with the inner range mark on the inside of the cuff. Make sure all fittings are tight, and that valve on inflation bulb is closed tightly. If there is doubt about the integrity of the system, perform the leak test before continuing.

8. Close the pressure release valve on the manometer inflation bulb and manually pump up the pressure until the manometer indicates approximately 220 mmHg.

9. Allow the pressure to stabilize for at least a minute. Then open the pressure release valve on the manometer inflation bulb and carefully bleed off pressure until the manometer indicates 200 mmHg.

10. Observe that the values of **PT1 Pressure** and **PT2 Pressure** on the menu indicate within 1 mmHg of the pressure shown on the manometer.

11. Verify the system linearity by repeating steps 8. and 9. for manometer indications of 250 mmHg, 150 mmHg, and 50 mmHg, and observe that **PT1 Pressure** and **PT2 Pressure** indicate within 3 mmHg of manometer readings for each of these pressure indications.

Pressure Recalibration

CAUTION

Calibration equipment should always be kept dry and free of particulate matter. Moisture or foreign substances introduced into the pneumatic system can cause damage to the unit.

1. Always enter Service Mode with the password, as described in Service Mode Operation, before attempting to recalibrate equipment.

2. Using the calibration kit (part number 320-246), an adult cuff and air hose, and a manometer, set up the equipment as shown in the NIBP Test Setup diagram. Do not connect hose to NIBP Module at first.

3. From the Service Menu, use the Select Knob to select the NIBP service parameter, and press the knob. The NIBP service menu should appear as shown in the NIBP Service Menu diagram.

4. Use the Select Knob to select **pneumatic reset**, and press the knob.

5. Use the Select Knob to select **valve close**, and press the knob.

7. Observe that both **PT1 Pressure** and **PT2 Pressure** display initial values of **0** on the menu.

8. Use the Select Knob to select **cal press zero**, and press the knob. Observe that the message **Inflate System to 200 mmHg Then Hit 'Cal Press 200'** is displayed on menu.

9. Connect hose to NIBP Module.

10. Fold the adult cuff so the index line is aligned with the inner range mark on the inside of the cuff. Make sure all fittings are tight, and that valve on inflation bulb is closed tightly. If there is doubt about the integrity of the system, perform the leak test before continuing.

11. Close the pressure release valve on the manometer inflation bulb and manually pump up the pressure until the manometer indicates approximately 220 mmHg.

12. Allow the pressure to stabilize for at least a minute. Then open the pressure release valve on the manometer inflation bulb and carefully bleed off pressure until the manometer indicates a little more than 200 mmHg.

13. Use the Select Knob to select **cal press 200**, but do not press the knob at first.

14. When the manometer indicates exactly 200 mmHg, press the Select Knob. Observe that system pressure is released, and the message **!!!!! CAL INFO NOT SAVED !!!!!** is displayed on menu.

15. Use the Select Knob to select **save cal info**, and press the knob. If the system is operating normally, the menu displays **Service Error: None**, and the calibration setting is saved.

16. Repeat the calibration check procedure to confirm the calibration setting.

Overpressure Tests

CAUTION

Calibration equipment should always be kept dry and free of particulate matter. Moisture or foreign substances introduced into the pneumatic system can cause damage to the unit.

1. Using the calibration kit (part number 320-246), an adult cuff and air hose, and a manometer, set up the equipment as shown in the NIBP Test Setup diagram. Connect the hose to the NIBP Module. Make sure all fittings are tight, and that valve on inflation bulb is closed tightly.

2. From the Service Menu, use the Select Knob to select the NIBP service parameter, and press the knob. The NIBP service menu should appear as shown in the NIBP Service Menu diagram.

3. Use the Select Knob to select **pneumatic reset**, and press the knob.

4. Use the Select Knob to select **valve close**, and press the knob.

5. Observe that the menu displays **Overpressure Selected Adult**. If not, use the Select Knob to select **adult ovp select**, and press the knob.

6. Use the Select Knob to select **inflate on**, and press the knob. The pump should begin to inflate the system.

7. Watch the pressure indication increase on the manometer, and observe that the pump is shut down and the pressure is released when the manometer indicates in the range of 300 to 330 mmHg. Observe that the menu displays **Service Error: None**.

8. Use the Select Knob to select **pneumatic reset**, and press the knob.

9. Use the Select Knob to select **valve close**, and press the knob.

10. Use the Select Knob to select **neo ovp select**, and press the knob. Observe that the menu displays **Overpressure Selected Neo**.

11. Use the Select Knob to select **inflate on**, and press the knob. The pump should begin to inflate the system.

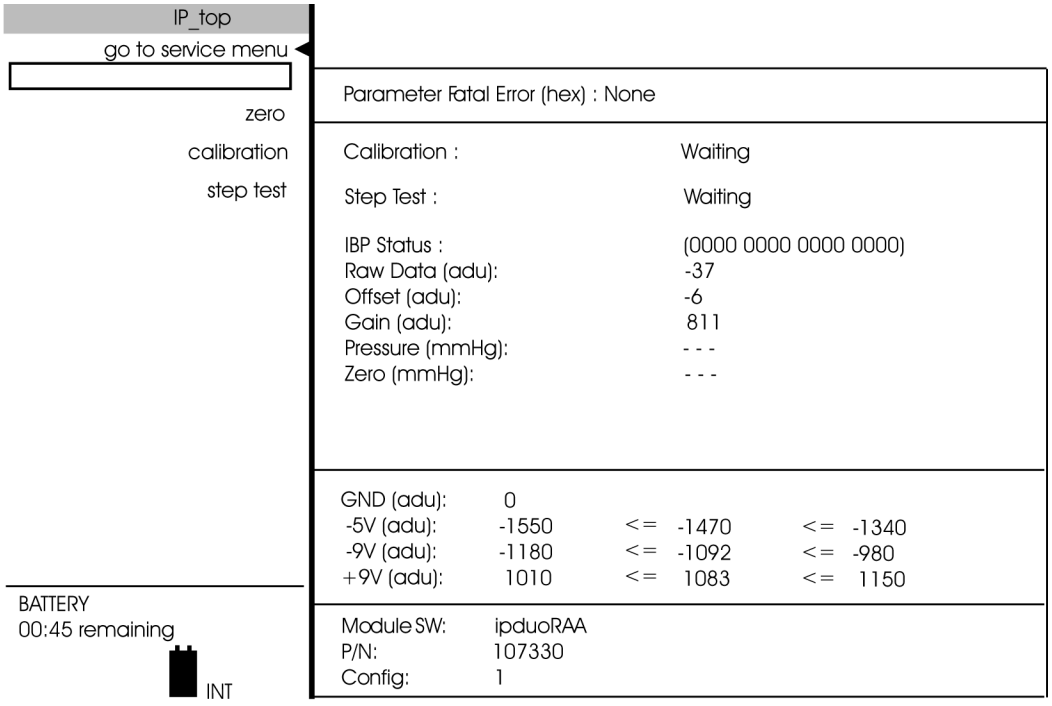
12. Watch the pressure indication increase on the manometer, and observe that the pump is shut down and the pressure is released when the manometer indicates in the range of 150 to 165 mmHg. Observe that the menu displays **Service Error: None**.

IP Tests

1. Disconnect all sensor cables from the INVASIVE PRESS (IP) Module, and ensure that the Module is installed.

2. Always enter Service Mode with the password, as described in Service Mode Operation, before attempting to recalibrate equipment.

3. From the Service Menu, use the Select Knob to select the **IP_top** service parameter, and press the knob. The IP-top service menu should appear similar to that shown below. The menu should display **Calibration: Waiting** and **Step Test: Waiting**.



4. Using a BP transducer simulator (Dynatech Nevada model 214 or equivalent) with 0 mmHg output selected, connect the simulator cable (part number 3010-0076 or equivalent) to the upper connector of the Module. The code for **IBP Status** should change.

5. Use the Select Knob to select **zero**, and press the knob. Some of the displayed parameters will change.

6. Use the Select Knob to select **calibration**, and press the knob. After a few seconds, the menu should display **Calibration: Passed**, and the **Pressure** parameter should return to **- - -**.

7. Use the Select Knob to select **step test**, and press the knob. After a few seconds, the menu should display **Step Test: Passed**.

8. Use the Select Knob to select **go to service menu**, and press the knob.

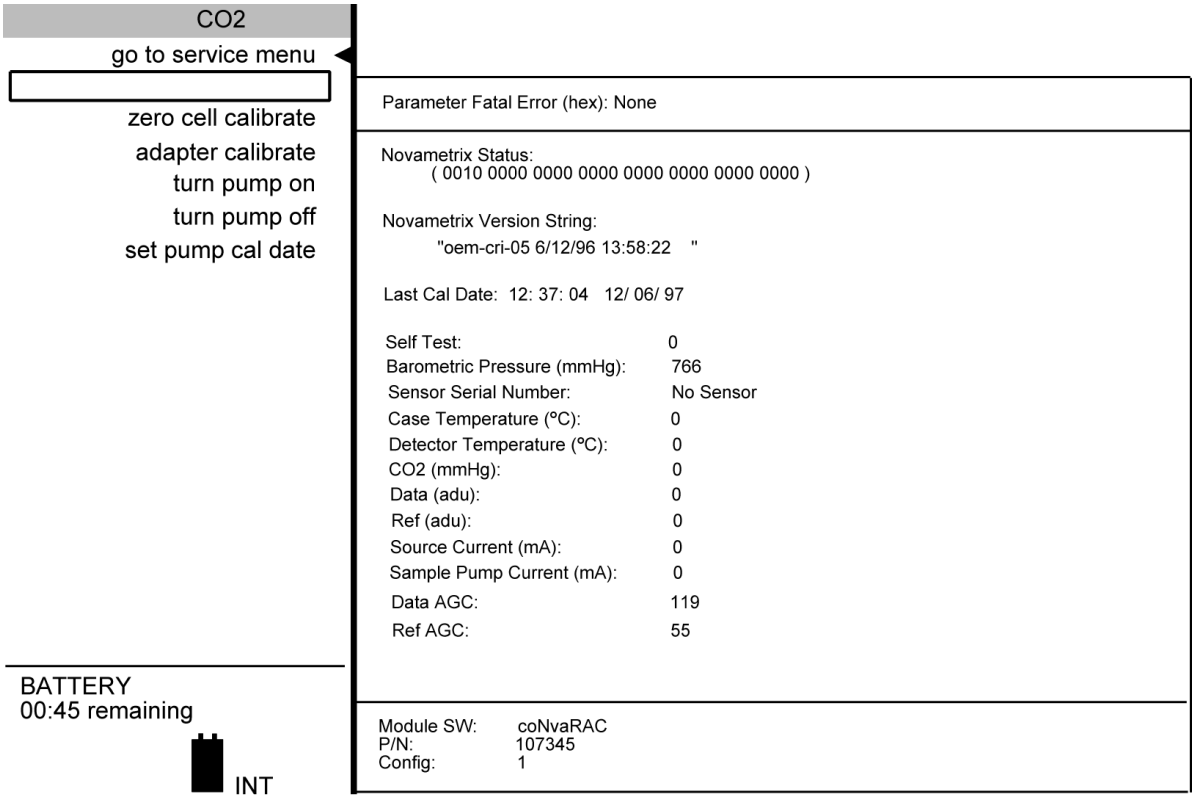
9. From the Service Menu, use the Select Knob to select the **IP_bottom** service parameter, and press the knob. The IP-bottom service menu should appear similar to that shown previously.

10. Repeat steps 5. through 7. with the transducer simulator cable connected to the lower connector of the Module.

CO2 Tests

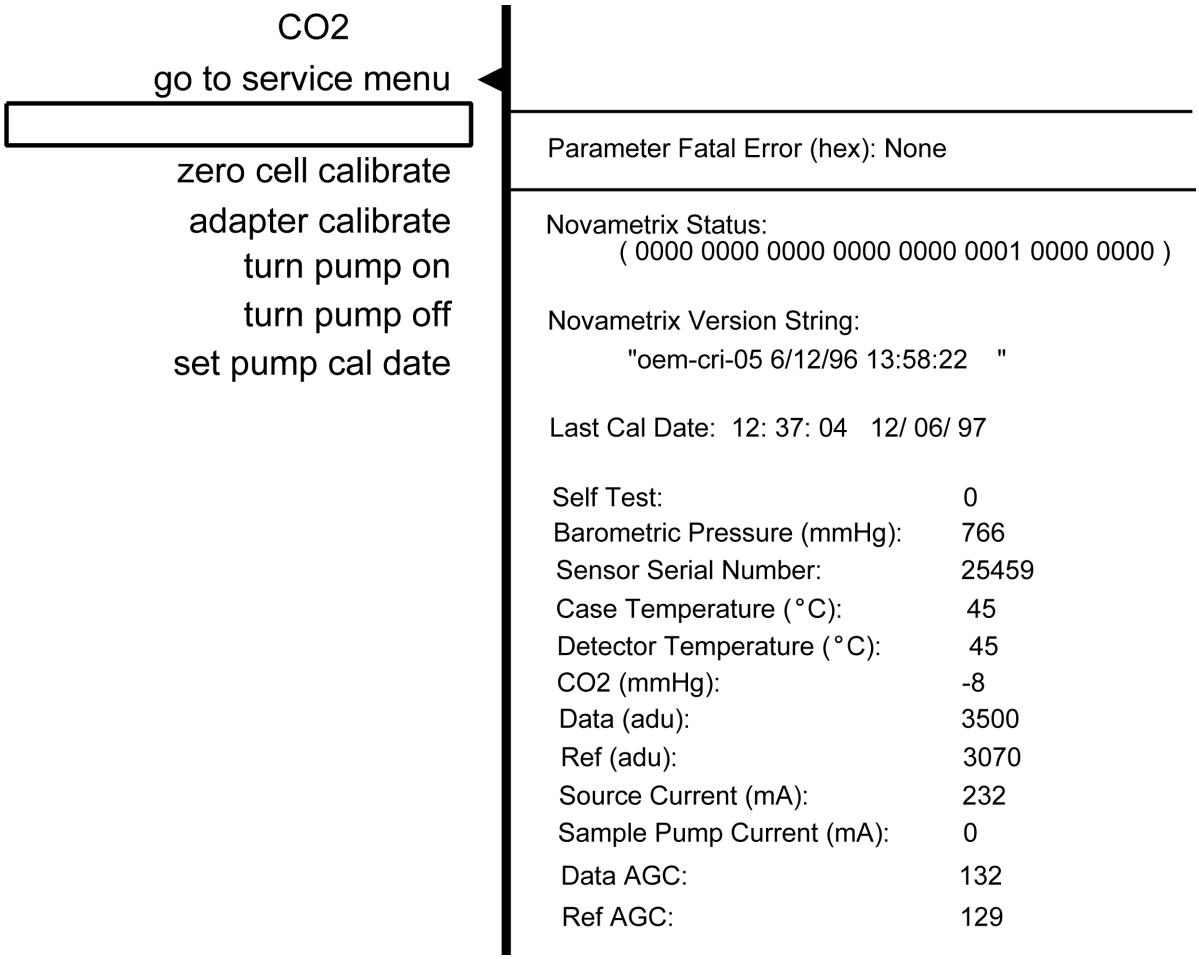
1. Disconnect all sensor cables from the CO2 Module, and ensure that the Module is installed.

2. From the Service Menu, use the Select Knob to select the CO2 service parameter, and press the knob. The CO2 service menu should appear similar to that shown below.



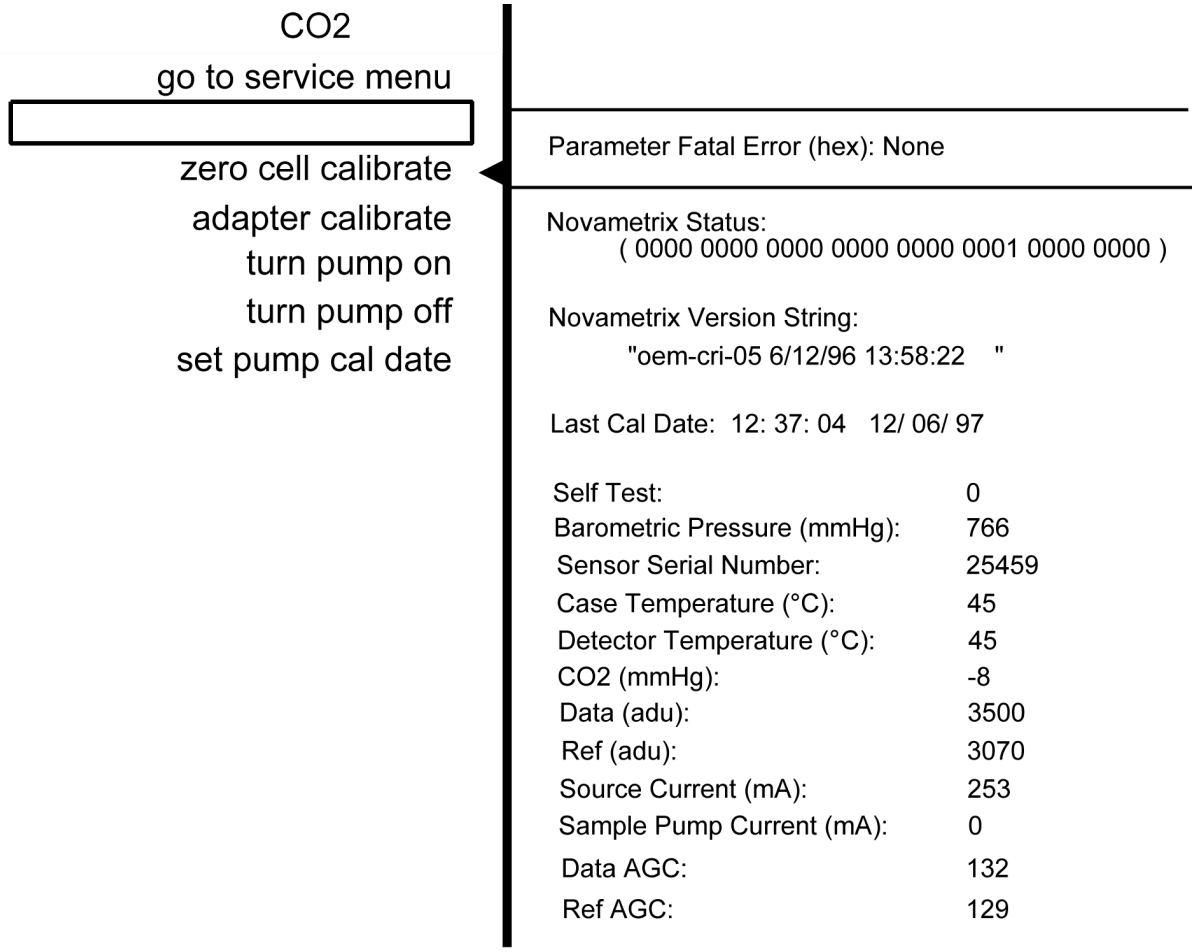
3. As shown above, **Parameter Fatal Error (hex) : None** should display, and remain displayed throughout this procedure. Barometric Pressure (mmHg) should be a valid value (displays about 760 mmHg at sea level).

4. Connect the CO2 sensor cable to the front panel connector of the CO2 Module, and install the sensor on the zero (0) cell. The Novametrix Status bits display will change for up to about 3 to 5 minutes while the sensor is warming. Once the sensor is warm, observe that the menu appears as shown below.

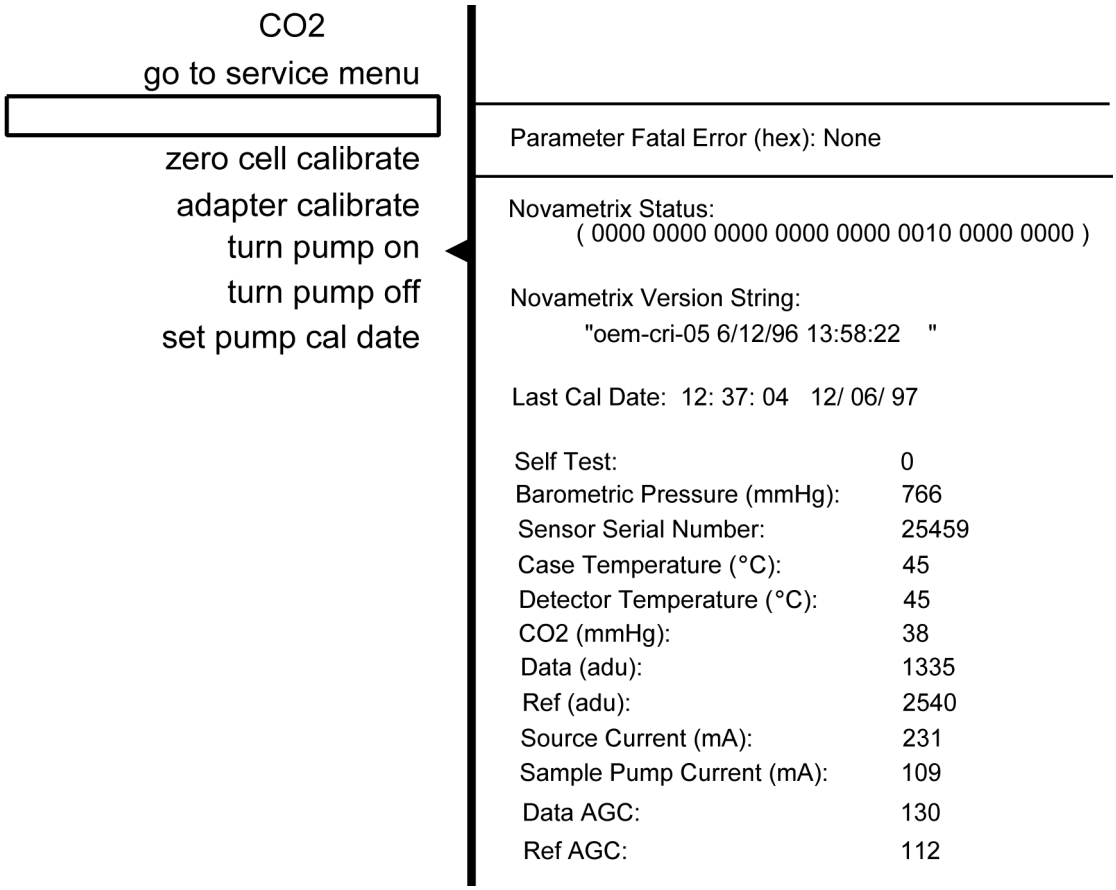


5. Observe that the menu displays a valid sensor serial number, that the case and detector temperatures are stabilized at approximately 45° C, and that other displayed values are similar to those shown above.

6. With the sensor still on the zero cell, use the Select Knob to select **zero cell calibrate**, and press the knob. The Novametrix Status bits may change for about 20 seconds, then should appear as shown below. Other displayed values may also appear changed as shown.



7. Install the sensor on the reference (REF) cell. Observe that the menu displays the Novametrix Status bits as shown below, and that CO2 = 38 mmHg ±1 mmHg.



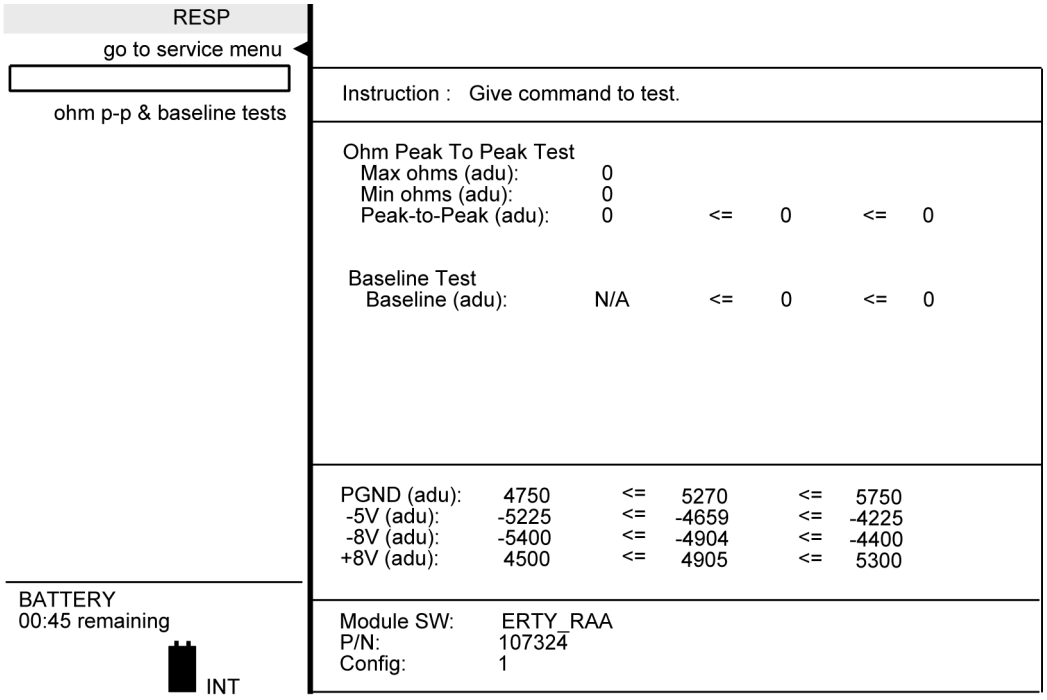
8. Using the Select Knob, select **turn pump on**, and activate the pump by pressing the knob. Verify that the menu displays a valid pump current similar to that shown above.

9. Using the Select Knob, select **turn pump off**, and deactivate the pump by pressing the knob.

RESP Tests

1. Disconnect sensor cable from EKG connector on front panel of EKG Module, and ensure that the EKG Module is installed.

2. From the Service Menu, use the Select Knob to select the RESP service parameter, and press the knob. The RESP service menu should appear similar to that shown below.


RESP
go to service menu
ohm p-p & baseline tests
BATTERY
00:45 remaining
INT
Instruction : Give command to test.
Ohm Peak To Peak Test
Max ohms (adu): 0
Min ohms (adu): 0
Peak-to-Peak (adu): 0 <= 0 <= 0
Baseline Test
Baseline (adu): N/A <= 0 <= 0
PGND (adu): 4750 <= 5270 <= 5750
-5V (adu): -5225 <= -4659 <= -4225
-8V (adu): -5400 <= -4904 <= -4400
+8V (adu): 4500 <= 4905 <= 5300
Module SW: ERTY_RAA
P/N: 107324
Config: 1

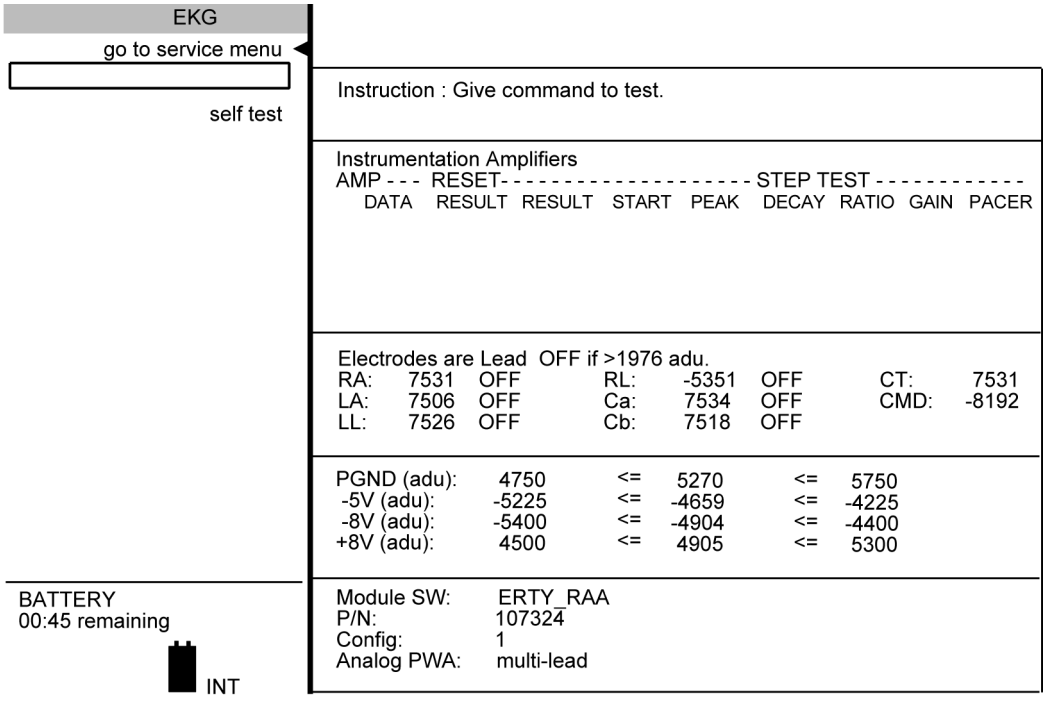
3. Use the Select Knob to select **ohm p-p & baseline tests**, and press the knob. Observe that the status area at the top of the menu displays **Please wait…testing**, and the test results area is blacked out.

4. When the testing is completed after several seconds, observe that there are no error messages, and that the test results area displays values within the required tolerances.

EKG Tests

1. Disconnect sensor cable from EKG connector on front panel of EKG Module, and ensure that the EKG Module is installed.

2. From the Service Menu, use the Select Knob to select the EKG service parameter, and press the knob. The EKG service menu should appear similar to that shown below.


EKG
go to service menu
self test
Instruction : Give command to test.
Instrumentation Amplifiers
AMP - - - RESET- STEP TEST - - - - - - - - - - - -
DATA RESULT RESULT START PEAK DECAY RATIO GAIN PACER
Electrodes are Lead OFF if >1976 adu.
RA: 7531 OFF RL: -5351 OFF CT: 7531
LA: 7506 OFF Ca: 7534 OFF CMD: -8192
LL: 7526 OFF Cb: 7518 OFF
PGND (adu): 4750 <= 5270 <= 5750
-5V (adu): -5225 <= -4659 <= -4225
-8V (adu): -5400 <= -4904 <= -4400
+8V (adu): 4500 <= 4905 <= 5300
BATTERY
00:45 remaining
INT
Module SW: ERTY_RAA
P/N: 107324
Config: 1
Analog PWA: multi-lead

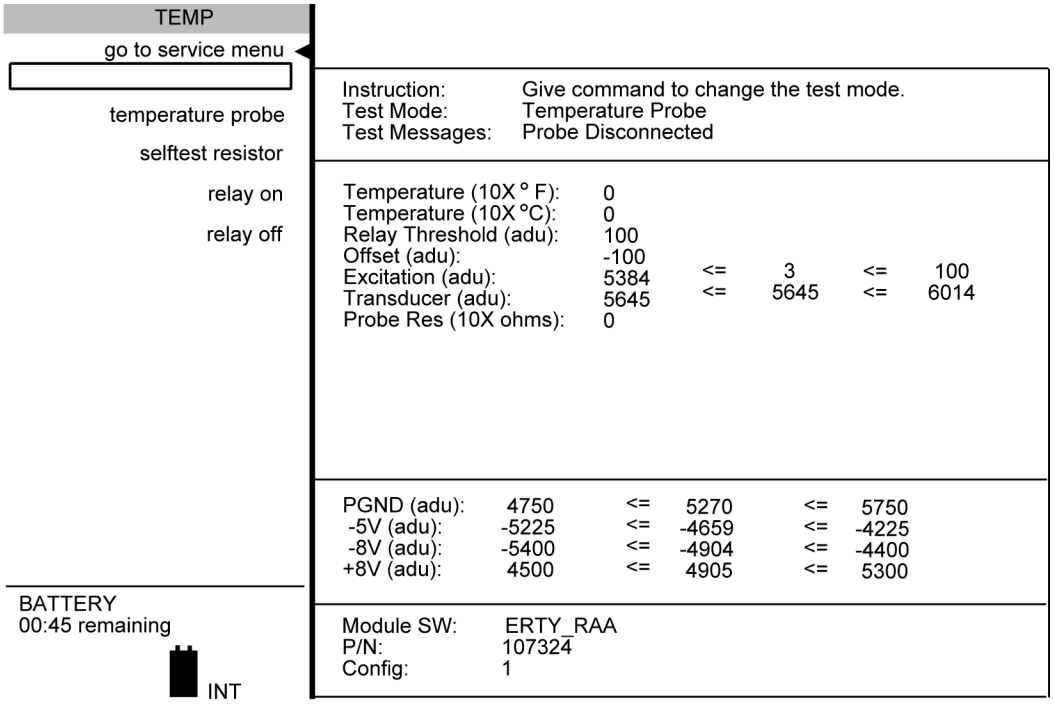
3. Use the Select Knob to select **self test**, and press the knob. Observe that the self test sequence begins, and that **test in progress** is displayed as the system sequences through the tests for each of the EKG channel amplifiers.

4. When all amplifers have been tested, observe that test results are displayed in the **Instrumentation Amplifiers** area of the menu. Results should indicate **OK**.

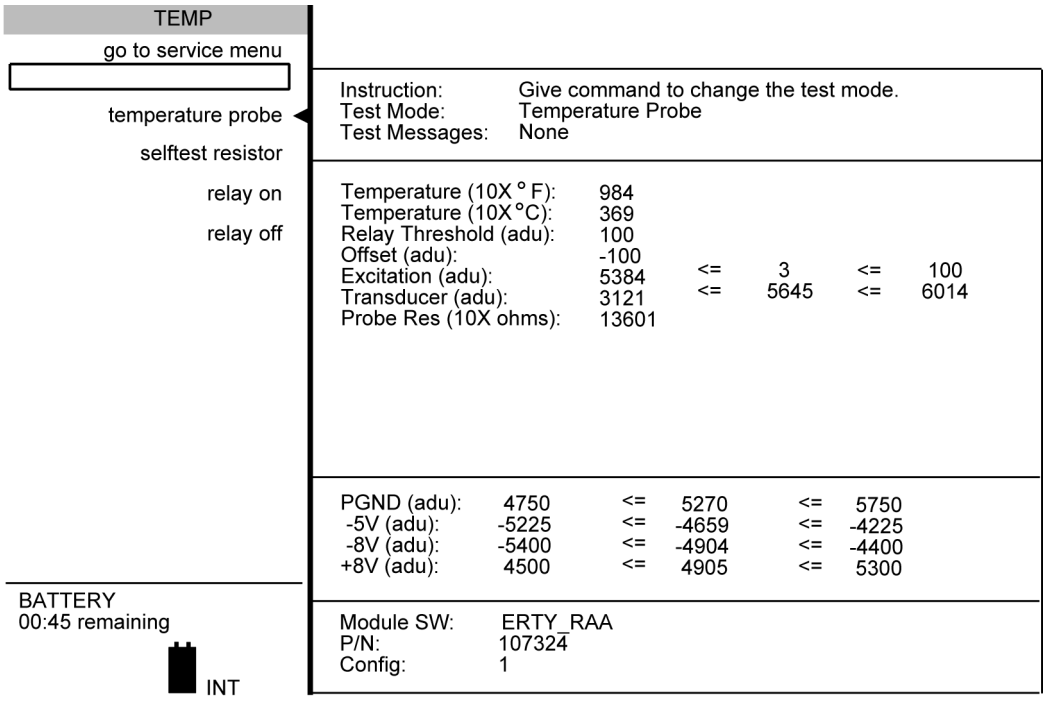
TEMP Tests

1. Disconnect all sensor cables from the EKG/TEMP/RESP Module, and ensure that the Module is installed.

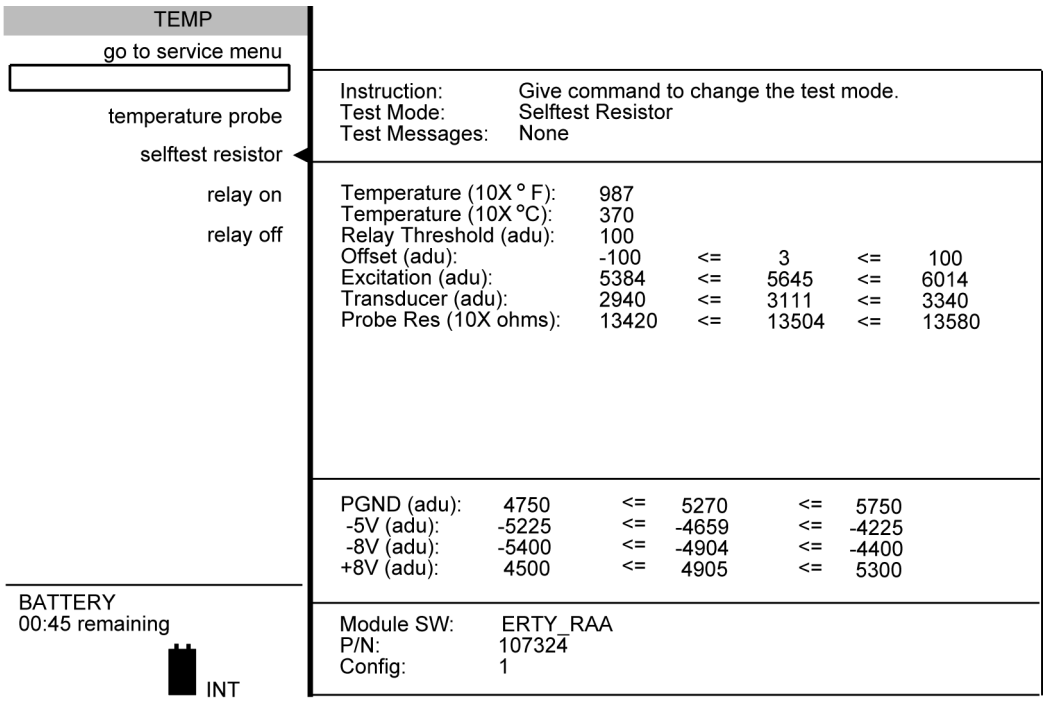
2. From the Service Menu, use the Select Knob to select the TEMP service parameter, and press the knob. The TEMP service menu should appear as shown below.


TEMP
go to service menu
temperature probe
selftest resistor
relay on
relay off
BATTERY
00:45 remaining
INT
Instruction: Give command to change the test mode.
Test Mode: Temperature Probe
Test Messages: Probe Disconnected
Temperature (10X ° F): 0
Temperature (10X °C): 0
Relay Threshold (adu): 100
Offset (adu): -100
Excitation (adu): 5384 <= 3 <= 100
Transducer (adu): 5645 <= 5645 <= 6014
Probe Res (10X ohms): 0
PGND (adu): 4750 <= 5270 <= 5750
-5V (adu): -5225 <= -4659 <= -4225
-8V (adu): -5400 <= -4904 <= -4400
+8V (adu): 4500 <= 4905 <= 5300
Module SW: ERTY_RAA
P/N: 107324
Config: 1

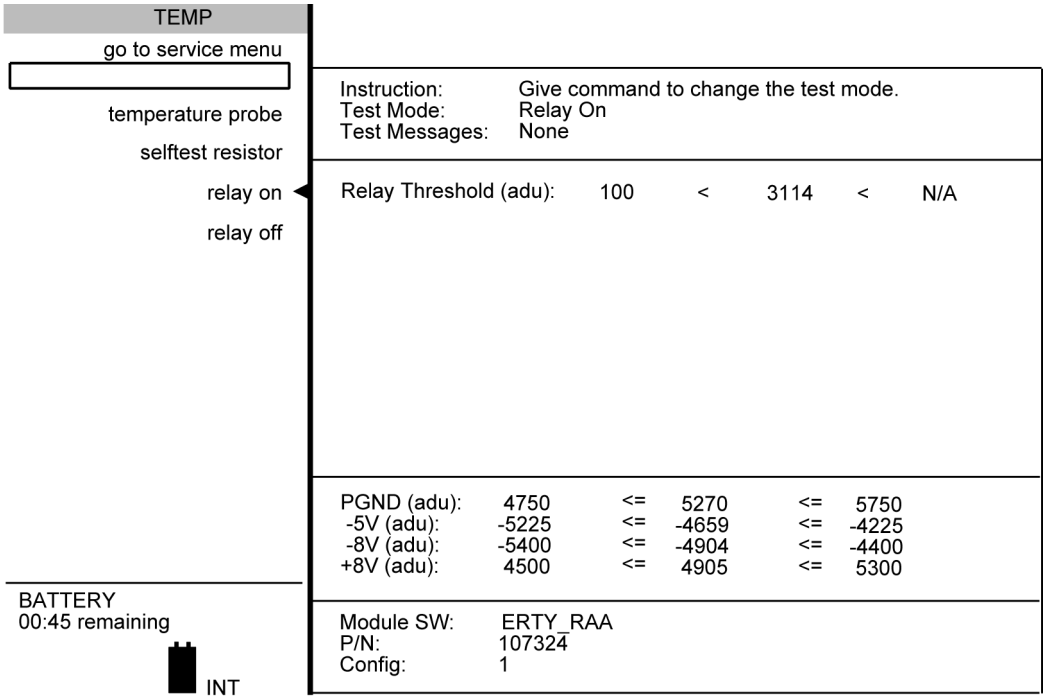
3. Using a temperature simulator (Dynatech Nevada model 214 or equivalent) with the temperature set to 37° C (98.6° F), connect the simulator cable to the Module. Use the Select Knob to select **temperature probe**, and press the knob, and observe that the menu appears as shown below. The measured values should be within the indicated ranges, and no error messages should appear. The temperature value should be within ± 0.1° C of 37.0° C (plus the error of the simulator). If no simulator is available, a decade resistance box set for 1355.3 ± 5.5 Ohms may be used.



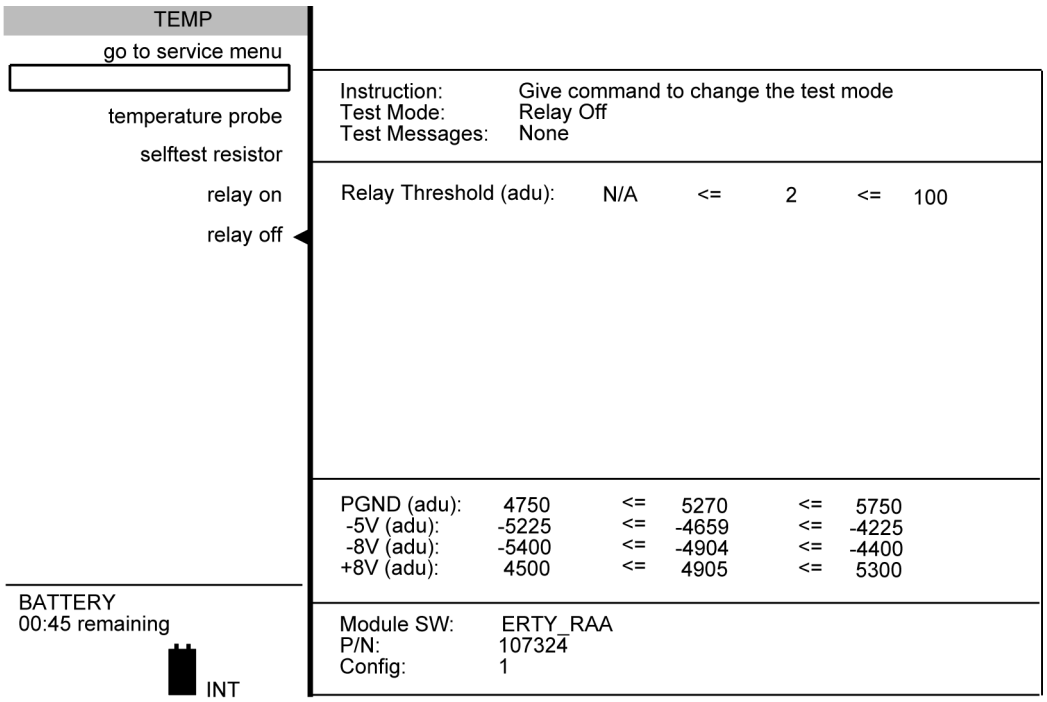
4. Use the Select Knob to select **selftest resistor**, and press the knob. The menu should appear as shown below. The measured values should be within the indicated ranges, and no error messages should appear.


TEMP
go to service menu
temperature probe
selftest resistor
relay on
relay off
BATTERY
00:45 remaining
INT
Instruction: Give command to change the test mode.
Test Mode: Selftest Resistor
Test Messages: None
Temperature (10X °F): 987
Temperature (10X °C): 370
Relay Threshold (adu): 100
Offset (adu): -100 <= 3 <= 100
Excitation (adu): 5384 <= 5645 <= 6014
Transducer (adu): 2940 <= 3111 <= 3340
Probe Res (10X ohms): 13420 <= 13504 <= 13580
PGND (adu): 4750 <= 5270 <= 5750
-5V (adu): -5225 <= -4659 <= -4225
-8V (adu): -5400 <= -4904 <= -4400
+8V (adu): 4500 <= 4905 <= 5300
Module SW: ERTY_RAA
P/N: 107324
Config: 1

5. Use the Select Knob to select **relay on**, and press the knob. The menu should appear as shown below. The measured values should be within the indicated ranges, and no error messages should appear.



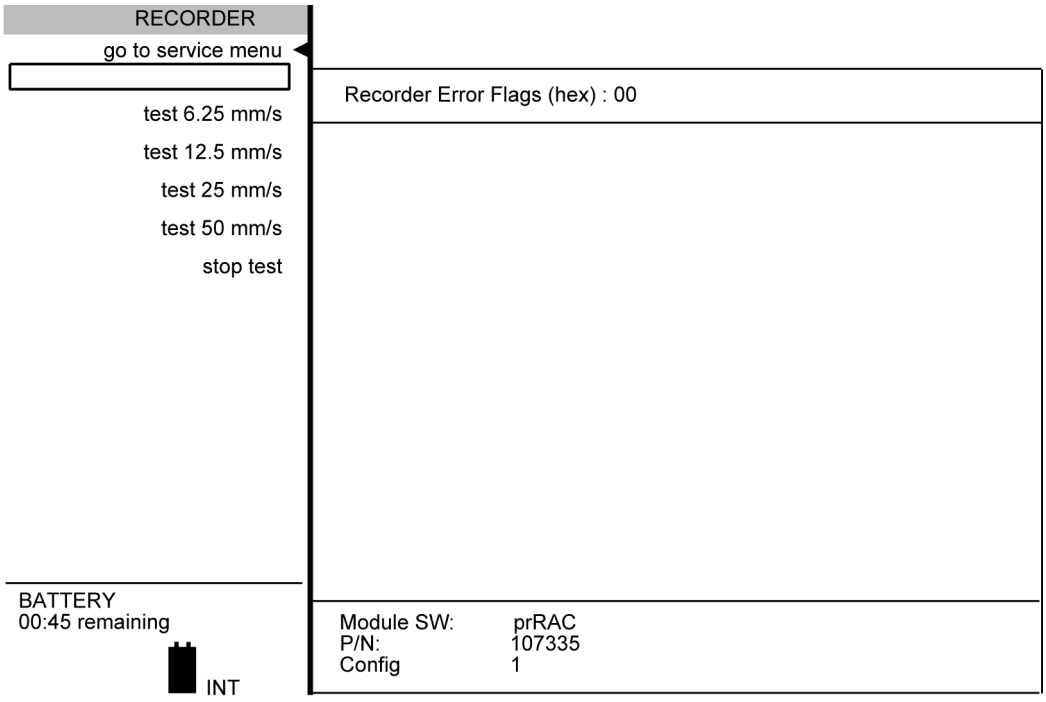
6. Use the Select Knob to select **relay off**, and press the knob. The menu should appear as shown below. The measured values should be within the indicated ranges, and no error messages should appear.



RECORDER
Tests

1. Ensure that paper has been loaded into the Recorder Module, and that the Module is installed.

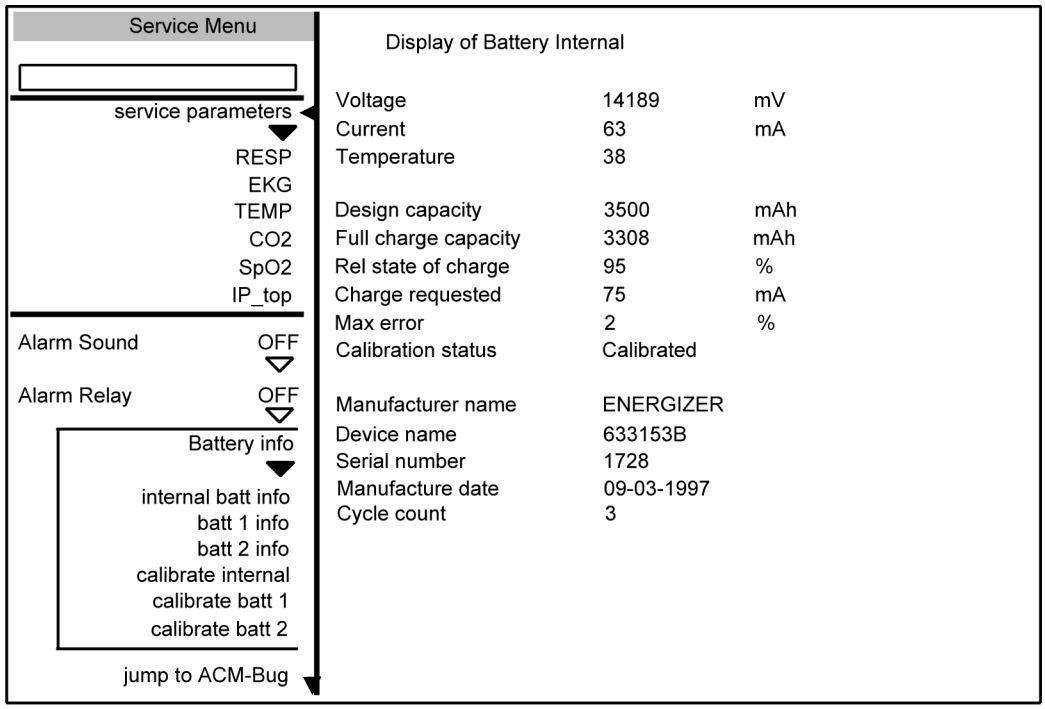
2. From the Service Menu, use the Select Knob to select the RECORDER service parameter, and press the knob. The RECORDER service menu should appear as shown below.



3. Use the Select Knob to move among the various paper speed tests. Press the knob to start a test. After a few seconds, test waveforms and text should appear on the printout. Use the **stop test** menu selection to stop the test printout when a sufficient printout is obtained. Refer to troubleshooting if any printing problems are encountered.

Battery Tests

1. From the Service Menu, rotate the Select Knob to select **Battery info**, and press the knob. The **Display of Battery Internal** menu should appear as shown below. Refer to Table 3-1 for a description of displayed data.



2. If the **Calibration status** does not indicate **Calibrated**, rotate the Select Knob to select **calibrate internal**. The **Requires calibration** message should appear, indicating the unit must remain connected to the external AC power supply for up to 6 hours. If this is not possible, select **no**.

NOTE

Maximum calibration accuracy is obtained by loading the Monitor with the same complement of parameter modules normally used with the unit before beginning calibration. To reduce total time required, calibrate several batteries at the same time, one after the other.

Failsafe Logic Test

1. From the Service Menu, rotate the Select Knob to select **test fail-safe logic** near the bottom of the screen, and press the knob. A dialogue box will appear. Answer **yes** to the question.

2. After four seconds, the system will freeze and an alarm will sound. Recycle the system power using the on/off button at the rear of the Monitor (press once to power off, wait five seconds, then press once to power on).

Keypad LED Test

1. From the Service Menu, rotate the Select Knob to select **keypad LED test** near the bottom of the screen, and press the knob. Observe that each of the five hardkeys on the display flashes the two colors (red, then off, then amber for the Silence key and green, then off, then amber for each of the other keys) that are possible, one key at a time. Observe whether any key fails to light.

2. After all keys have been tested, press the Select Knob at the **keypad LED test** position to stop the test procedure.

Service Mode Exit

To exit the service mode and power off the Monitor, locate the on/off button at the rear of the Monitor and press the button twice.